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PARAMETERIZING GEOSTROPHIC EDDIES IN OCEAN MODELS: ENERGETICS, POTENTIAL VORTICITY MIXING AND FLOW INSTABILITY

A new framework is presented for parameterizing geostrophic eddies in ocean models. The proposed eddy closures flux potential vorticity down-gradient along density surfaces and satisfy an energy conservation relation by solving an explicit budget for the eddy energy. The latter is, in turn, related to the eddy transfer coefficient through a simple scaling relation. When energy conservation is satisfied in this manner, the growth or decay of the parameterised eddy energy is related naturally to the instability or stability of the flow as described by Arnold's first stability theorem. Thus the resultant family of eddy closures possess some necessary ingredients to parameterize the gross effects of eddies in both forced-dissipative and freely-decaying turbulence. An important issue concerns parameterization of the dispersion and dissipation of the eddy energy, for which some simple schemes are suggested. These ideas are illustrated through applications to wind-driven circulation and freely decaying turbulence in ocean basins, with both explicitly resolved and parameterized eddies. Preliminary results will also be presented from an ocean general circulation model in which the Gent and McWilliams eddy closure is modified to include an explicit eddy energy budget following the above procedure. Extensions of this approach to include angular momentum constraints will also be discussed.

Oral presentation

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